

TRANSLATOR'S DECLARATION

I, CHRISTA SCHAEERTEL, declare and say:

1. That I reside at 413 South Fayette Street, Alexandria, Virginia 22314;

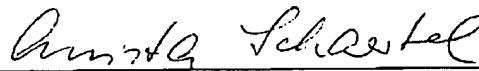
2. That I am thoroughly familiar with the German, French and English languages, holding Translator's and Interpreter's Diplomas from the Institute of Interpreting and Foreign Languages, Goettingen, Germany, and the Chamber of Industry and Commerce of Wiesbaden, Germany;

3. That I translated the PCT/EP2004/008734 International Application with the title

SEPARATOR COMPRISING A SPINNING DRUM WITH A DISC STACK

written in the German language; and

That the attached is a correct English translation of the above-mentioned German-language document to the best of my knowledge and belief.



Christa Schaertel

Date: February 13, 2006

ENGLISH TRANSLATION OF  
PCT/EP2004/008734  
SPECIFICATION, CLAIMS, 5 SHEETS  
OF 10 FIGURES AND COVER PAGE  
(21 pages)

## SEPARATOR COMPRISING A SPINNING DRUM WITH A DISC STACK

- [0001]** The invention relates to a separator according to the preamble of Claim 1.
- [0002]** It has been known for a long time to arrange disc stacks consisting of a plurality of discs situated axially above one another in the direction of the disc axis concentrically to the machine or drum axis in centrifugal drums of separators, thus, from the field of separators with drums with a vertical axis of rotation and solids discharge openings in a pulp space outside the disc stack.
- [0003]** In the case of separators with a vertical axis of rotation, a feeding of the product into the centrifugal drum takes place along the drum axis through a feeding pipe and radial distributor channels connected behind the feeding pipe, in which centrifugal drum the product enters into the disc stack consisting of (separating) discs which are generally situated closely above one another but are nevertheless spaced relative to one another in the area of the essential disc surfaces and, as a rule, are conical. At the discs, heavier solids generally accumulate on the bottom side and move to the outer circumference of the disc stack, while the liquid flows toward the interior (two-phase liquid-solid separation).
- [0004]** Particularly - but not only - for the implementation of a liquid-liquid-solid separation (three phase liquid-solid separation), it is also known to provide the disc stack with so-called rising channels, which are formed of bores in the discs of the disc stack situated directly or with a twist (German Patent Document DE 100 55 398 A1) above one another.
- [0005]** From U.S. Patent Document US 993,791, a chamber centrifuge is known which has no solids discharge openings and in the case of which the diameter of the bores changes within a disc stack or the orientation of the openings is changed from one disc to the next in that a disc holding contour sloped toward the axis of rotation is arranged, for example, at the shaft.

**[0006]** The discharge of the liquids generally takes place in areas radially on the inside or radially on the outside with respect to the discs of the disc stack. It is also known to construct discharge channels for the liquid phase(s) by means of bores particularly close to the inner circumference as well as close to the outer circumference of the disc stack in the disc stack (see, for example, German Patent Document DE 284640).

**[0007]** It is also known to equip the discs with so-called spacers in the manner of webs and/or small tips (points) which, on the one hand, provide a mutual spacing of the discs and, on the other hand, influence the flow conditions in the disc stack. Spacers can be placed between the discs which preferably are separate from the latter. The discs are generally held in grooves on a distributor shaft or in other disc holders.

**[0008]** In contrast, it is an object of the invention to optimize the flow conditions in the drum of a separator of the above-mentioned type by means of simple constructive devices.

**[0009]** The invention solves this task by means of the object of Claim 1.

**[00010]** Advantageous embodiments are contained in the subclaims.

**[00011]** According to the characterizing feature, the diameter of the at least one channel within the disc stack above the lowermost disc in the flow direction is not constant and/or that the channel is arranged in a sloped manner with respect to the axis of the drum and the bores of the at least one distributor channel do not have a radial orientation to the drum axis in the drum.

**[00012]** By means of each of these three measures, - depending on the product -, it becomes possible, particularly in the case of a centrifuge with a pulp space outside the disc stack (with a piston valve arrangement or solids discharge nozzles) to optimize the flow conditions in the drum. Particularly advantageously, the combination of at least two or - even better - all three of these measures - distributor and channel geometry and/or channel orientation - is utilized for optimizing the flow conditions in the centrifuge in a constructively simple manner and to optimally adapt them to the product to be processed.

**[00013]** German Patent Document DE 38 80 19 shows a centrifuge of a different type with an inlet pipe which is not concentrically arranged.

**[00014]** Particularly preferably, the geometry of the bores of the discs of a rising channel varies in the channel in such a manner that, during the operation, the gaps between the discs are uniformly charged with liquid over the entire height of the disc stack. As a result of this advantageous measure, the flow conditions in the centrifuge are particularly clearly optimized. Thus, not only a simple widening of the bores "from one disc to the next" is implemented but a flow-dependent optimization, in the case of which the bores can be designed to be constant also over several discs and will then, for example, widen. In this manner, each disc separately can have an optimal design. On the production side, this can be particularly easily implemented by laser cutting the bores in the metal sheet of the discs.

**[00015]** For example, the diameter of the channel can change in steps at a distance of several discs or continuously from one disc to the next; in particular, decrease in the flow direction. It is particularly expedient for the diameter to decrease, for example, continuously, in the flow direction.

**[00016]** The bores per se may have an arbitrary shape. The optimal shape is determined by a person skilled in the art by tests as a function of the product. Thus, the bores may have a polygonal or round or curved shape, specifically, in any alignment.

**[00017]** According to another advantageous variant, each channel consists of several bores which, in turn, particularly advantageously may also form a perforated pattern - for example, distributed on the circumference on a circle or an ellipse - in the discs.

**[00018]** It is also conceivable that the at least one sloped channel extends in a curved manner with respect to the drum axis in the disc stack.

**[00019]** In this case, the channel/channels may particularly preferably comprise a rising channel for feeding the product into the disc stack and/or, particularly advantageously, at least one discharge channel for discharging the liquid phase from the disc stack. The optimized design of rising and discharge channels also contributes to improving the flow conditions.

**[00020]** Particularly preferably, one of the discharge channels respectively for discharging various liquid phases is constructed close to the inner circumference or close to the outer

circumference of the disc stack is constructed inside the disc stack. The flow direction extends in the direction of the liquid discharges of the drum, with the vertical orientation generally in the upward direction.

**[00021]** By means of one or more of the above-described measures, it becomes possible by means of simple experiments to optimize the further development of the channels of a separator with a vertical axis of rotation as a function of the product and the machine in order to improve the parallel connection of the discs of the disc stack and to optimize the flow conditions in order to, for example, compensate separating zone displacements because of pressure differences in the disc stack (radial position) and to reduce instabilities in the disc stack (in the circumferential direction).

**[00022]** The invention is expediently supplemented by the above-mentioned measure, which can also be considered independently, of providing a distributor with at least one distributor channel constructed as a bore in a distributor base, which distributor channel is not oriented radially in the drum, which, in turn, optimizes the flow conditions in a simple manner as a function of the product.

**[00023]** In many cases, it is, for example, advantageous for the distributor channels to preferably be oriented in a sloped manner against the rotating direction of the drum or under certain circumstances in the rotating direction of the drum.

**[00024]** The distributor channels, which are formed by bores relative to the radial line through the drum axis in a radially interior bore section against the rotating direction of the drum, advantageously are oriented to be sloped in a lagging manner.

**[00025]** As a result of this measure, the flow conditions are further optimized particularly also in combination with the measure that the distributor channels lead in a further bore section into the drum, which bore section is oriented upwards in the drum and leads out directly below a rising channel of the disc stack into the drum. In addition, a more careful acceleration and an optimal entry of the centrifugal material into the rising channels is ensured.

- [00026]** In this case, the distributor channels may have an expanding round or a slot-type outlet which extends tangentially in or against the rotating direction of the drum and/or is directed upward in the drum.
- [00027]** In the following, the invention will be explained in detail by means of embodiments with reference to the drawing.
- [00028]** Figures 1 to 8 are top views respectively of a partial area of different discs for disc-type centrifuges with a vertical axis of rotation;
- [00029]** Figure 9 is a sectional view of a schematically illustrated separator and of two distributor channels; and
- [00030]** Figure 10 is a top view of a distributor for a separator of the type of Figure 7.
- [00031]** Figure 1 is a top view of a partial area of a known disc 1 of a disc stack for a separator (otherwise not shown here).
- [00032]** According to Figure 1, the discs 1 each have a bore 2, the bores 2 or holes of the discs 1, in cooperation with several discs arranged above one another, forming a rising channel 3 which is situated radially in the area of the separating zone T between a lighter and a heavier liquid phase. In area 4, the discharge of a light liquid phase takes place radially on the inside with respect to the discs, and the discharge of a heavier liquid phase takes place in area 5 radially outside the disc 1. The solids exit the disc stack toward the outside (not shown here) and can be discharged there in a known manner, for example, through nozzles or a piston valve arrangement from the centrifugal drum.
- [00033]** The disc stack or the individual discs 1 are pushed onto the distributor shaft 16 which is equipped on its outer circumference with a plurality of webs 17 directed radially from the shaft to the outside, which webs 17 protrude beyond the inner circumference I of the discs 1 and thereby non-rotatably secure the discs 1 on the distributor shaft 16 relative to the latter.
- [00034]** As a radial extension of the webs 17, also radially directed spacers (lugs) 18 are arranged between the discs, which divide the discs completely into segments 19 with an opening angle  $\alpha$ , in which one bisecting line W respectively is situated.

- [00035]** The area 4 for discharging the light phase is formed by grooves 20 in the outer circumference of the distributor shaft 16 between the webs 17, which are placed symmetrically with respect to the bisecting lines W in the distributor shaft 16.
- [00036]** According to Figure 2, the rising channel 3 has a cross-section which is not constant; that is, the diameter of the bores 2 of the disks 1 of the disc stack, which form the rising channel, is not constant. It changes over the entire height of the disc stack (here, it is reduced continuously along the entire height of the disc stack in the flow direction).
- [00037]** It is noted that it is known from British Patent Document GB 264,777 to provide the lowermost disc with a different hole or bore arrangement than the upper discs in order to cover a portion of the discs and be able to thereby radially displace the rising channel by exchanging the lowermost disc.
- [00038]** The diameter of the bores 2 according to Figure 2 in the case of a drum with a vertical axis of rotation preferably continuously decreases in the upward direction (indicated by a broken line), so that the diameter of the rising channel 3 is also reduced in the upward direction.
- [00039]** In addition, the rising channel 3 according to Figure 2 is not situated parallel to the drum axis A (perpendicular to the plane of the figure). As a result, the bores 2 of discs 1 situated above one another are no longer aligned completely but only in sections, so that the rising channel may, example, extend in the upward direction radially from the outside farther toward the inside and/or in or against the rotating direction in the circumferential direction and may therefore have a twist.
- [00040]** According to Figure 2, the groove 20 in the distributor shaft for forming the discharge channel is not symmetrically aligned with respect to the bisecting line W of each disc segment 19 but is asymmetrically laterally offset. This can also optimize the flow conditions in the disc stack.
- [00041]** According to Figures 3 to 6, the discharge channels 6, 7 are constructed directly in the disc stack; that is, a first discharge channel 6 for a light liquid phase is in each case constructed radially outside the inner circumference I of the discs 1 in the disc stack, and a



second discharge channel 7 for a heavier liquid phase is constructed radially inside the outer circumference A of the discs 1. These also may be aligned not only symmetrically but also asymmetrically with respect to the bisecting line W of each disc segment 19. This also applies to the rising channels 2 for the product feed.

**[00042]** The discharge channels 6, 7 are formed analogously to the rising channels 3 by bores 8, 9 in the discs 1 situated above one another, which bores 8, 9 are situated close to the inner or outer circumference of the discs 1. The discharge channels 6, 7 may again have a diameter which is not constant and/or may not be situated directly above one another but offset with respect to one another relative to the drum axis. To this extent, all of the arrangements of the bores 2 for the rising channels 3 mentioned above or below can be analogously utilized also when further developing the bores 8, 9 for the discharge channels 6, 7.

**[00043]** According to Figure 3, the bores 8 of the inner discharge channel 6 for the light liquid phase and/or the bores 9 of the discharge channel 7 for the heavier phase and/or the bores 2 of the rising channel 3 may in each case again consist of several bores 2, 8, 9 in the manner of a multiple perforation 19. In this case, the individual bores can be arranged, for example, in a circle 12, particularly in a radially oriented straight line or in a curve oriented in the circumferential direction or a straight line 13. The curves or straight lines may be arbitrarily oriented in an angular and/or offset manner with respect to the bisecting line W of the segment or to other radial lines through the drum axis A of the centrifuge depending on the application.

**[00044]** It was found that the division of the product flow into many small channels represents an improvement with respect to the uniform charging of the disc stacks and optimizes the flow conditions in the disc stack.

**[00045]** The individual bores 2, 8, 9 may have any geometry; thus, a circular shape or a polygonal shape, for example, a triangular or square shape (Figure 4) or a curved shape (Figure 5). The polygon or the other geometrical shapes can be oriented at any angle with respect to the bisecting line W of the angle.

**[00046]** It is particularly advantageous to mutually adapt the geometry of the bores of a rising channel such that the gaps between the discs are uniformly charged with liquid over the entire height of the disc stack or the rising channel. This can be achieved by tests and/or theoretical considerations, such as computer simulations.

**[00047]** Figures 6 to 8 illustrate that, by means of an optimized further development of the distributor, it also and/or optionally becomes possible to further optimize the flow conditions in the drum as well as at the and in the disc stack.

**[00048]** Here, the preferably one-piece distributor is provided with distributor channels 14 which are not radially oriented, are constructed as a bore and, first (Figure 9) extend in a first bore section in the drum in a sloped manner from the inside to the outside in the downward direction and end in a bore section which is constructed as a preferably expanding or geometrically changing distributor outlet 15a. This distributor outlet 15a is directed upward in the drum 1 and preferably leads directly below one of the rising channels. Its outlet area may have a circular or, for example, slot-type shape. The slot-type distributor outlets 15b from the bores of the distributor channels 14 (Figure 6) may then, in turn, extend relative to the remaining distributor channel preferably tangentially to the radial line in (Figure 7) or against (Figure 8) the rotating direction of the drum, or may advance or lag.

**[00049]** In this manner, it becomes possible to optimize the flowing of the product into the drum as well as into the disc stack in a very targeted manner while the feeding bore cross-section is optimized, in order to achieve an improved separation of the particles and, if required, improve the parallel connection of the discs 1.

**[00050]** Figure 9 is a cross-sectional view of a schematically illustrated self-discharging separator having a drum 21 with a vertical axis of rotation D, which has a distributor 22. A feeding pipe, which is not shown, leads from above into the distributor 22. The distributor 22 has the upper distributor shaft 16, which is oriented concentrically with respect to the axis of rotation, as well as several distributor channels 14 which are constructed as bores and each lead into one of the distributor outlets 15a,b,c. A piston

valve 23 is used for the opening and closing of solids discharge openings 24. The liquid discharge from the drum 24 preferably takes place by means of grippers or centripetal pumps which are also not shown here.

**[00051]** Figure 10 is a corresponding top view of the distributor with the distributor shaft 16 and the lower, radially expanding, almost disc-type base section 25, which is penetrated by the, for example, three distributor channels 14 shown here by broken lines and leading into the distributor outlets 15a,b,c.

**[00052]** The straight bores, which form the distributor channels 14 in the particularly preferably one-piece distributor, in this case, are not arranged radially but relative to the radial line  $r$  through the drum axis  $M$  (which here is congruent with the axis of rotation  $D$  in the drawing) in a lagging manner with respect to the rotating direction, which permits a particularly careful inflow of the centrifugal material.

**[00053]** This is again preferably accompanied by the measure of designing the holes of the rising channel 14 not to be constant over the height of the disc stack but to design them in an optimized manner with respect to the flow conditions to not be constant (variable). The angle  $\beta$  between the distributor channels and the radial line  $R$ , which extends through the starting area of the distributor channel (14) at the inner circumference of the distributor, preferably amounts to between 15 and 85°, particularly between 25° and 65°, in order to achieve a particularly careful inflow of the centrifugal material into the drum.

**[00054]** The distributor outlets 15a,b,c may have various geometries which are also adapted to the rising channels and which again may be oriented to be lagging (15b), advancing (15c) or "neutral" (15a) relative to the lagging distributor arm (see also Figure 10).

## Reference Symbols

Disc	1
bore	2
rising channel	3
area	4
area	5
discharge channel	6
discharge channel	7
bores	8,9
multiple perforation	10
circle	12
straight line	13
distributor channel	14
distributor outlet	15a,b
distributor shaft	6
webs	17
spacers (lugs)	18
segments	19
grooves	20
drum	21
distributor	22
piston valve	23
solids discharge openings	24
expanding base section	25
inner circumference	I
outer circumference	A
separating zone	T

opening angle	$\alpha$
bisecting line of angle	W
radial line	R
rotating direction	r
axis of rotation	D